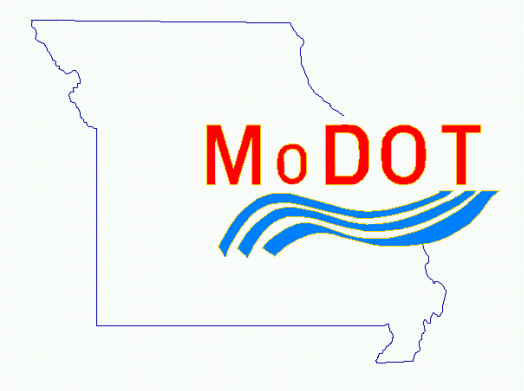


LRFD

Section 3.76

Revised: **May 2006**

CLICK HERE TO Index

Index

3.76.1 General

1.1 Material Properties

Concrete

Class B Concrete (Substructure) f'_c = 3.0 ksi
n = 10

Class B-1 Concrete (Substructure) may also be used in special cases (See Project Manager). The following equations shall apply to both concrete classes:

LRFD 5.4.2.4 Concrete modulus of elasticity, $E_c = 33000 K_1 w_c^{1.5} \sqrt{f'_c}$

Where:
w_c = unit weight of non-reinforced concrete = 0.145 kcf
K_1 = correction factor for source of aggregate = 1.0.

LRFD 5.4.2.6 Modulus of rupture: For minimum reinforcement, $f_r = 0.37\sqrt{f'_c}$

For all other calculations, $f_r = 0.24\sqrt{f'_c}$

$\sqrt{f'_c}$ is in units of ksi.

Reinforcing Steel

Minimum yield strength, f_y = 60.0 ksi

LRFD 5.4.3.2 Steel modulus of elasticity, E_S = 29000 ksi

3.76.2 Design

2.1 Limit States and Factors

In general, each component shall satisfy the following equation:

LRFD 1.3.2.1

$$Q = \sum \eta_i \gamma_i Q_i \leq \phi R_n = R_r$$

Where:

Q = Total factored force effect
Q_i = Force effect
η_i = Load modifier
γ_i = Load factor
ϕ = Resistance factor
R_n = Nominal resistance
R_r = Factored resistance

LRFD 5.5

Limit States

The following limit states shall be considered for abutment design:

STRENGTH – I
STRENGTH – III
STRENGTH – IV
STRENGTH – V
SERVICE – I
FATIGUE

See LRFD Table 3.4.1-1 and LRFD 3.4.2 for Loads and Load Factors applied at each given limit state.

Resistance factors

LRFD 6.5.4.2 & 5.5.4.2 *STRENGTH* limit states, see *LRFD 6.5.4.2* and *LRFD 5.5.4.2*

LRFD 1.3.2.1 For all other limit states, ϕ = 1.00

LRFD 1.3.2.1

Load Modifiers

For loads where a maximum value of load factor is appropriate:

$$\eta = (\eta_I \ \eta_R \ \eta_D) \geq 0.95$$

For loads where a minimum value of load factor is appropriate:

$$\eta = 1 / (\eta_I \ \eta_R \ \eta_D) \leq 1.0$$

Where:

LRFD 1.3.3 η_D = Factor relating to ductility
LRFD 1.3.4 η_R = Factor relating to redundancy
LRFD 1.3.5 η_I = Factor relating to operational importance

Table 3.76.2.1 Load modifiers

	All Limit States
Ductility, η_D	1.0
Redundancy, η_R	1.0
Operational importance, η_I	1.0
$\eta = (\eta_I\ \eta_R\ \eta_D)$	1.0
$\eta = 1 / (\eta_I\ \eta_R\ \eta_D)$	1.0

2.2 Loads

See LRFD DG Sec. 1.2 Loads for distribution and magnitudes of loads to be applied for abutment design.

Dead Loads

Loads from stringers, girders, etc. shall be applied as concentrated loads applied at the centerline of bearing. Loads from concrete slab spans shall be applied as uniformly distributed loads.

Live Loads

Loads from stringers, girders, etc. shall be applied as concentrated loads applied at the centerline of bearing. Dynamic load allowance (impact) should be included for the design of the beam. No dynamic load allowance should be included for foundation design.

For wings with detached wing walls, no portion of the bridge live load shall be distributed to the detached wall. The detached wing wall shall be designed as a retaining wall as specified in LRFD DG Sec. 3.62. The weight of the safety barrier curb on top of the wall shall be included in the dead load.

Collision

LRFD 3.6.5.2

Collision shall be designed if abutments are located within a distance of 30.0 feet to the edge of roadway, or within a distance of 50.0 feet to the centerline of a railway track and conditions do not qualify for exemptions given in LRFD DG Sec. 1.2.2.5-2. If designed for, the collision force shall be a static force of 400 kips assumed to act in any direction in a horizontal plane, at a distance of 4.0 feet above ground.

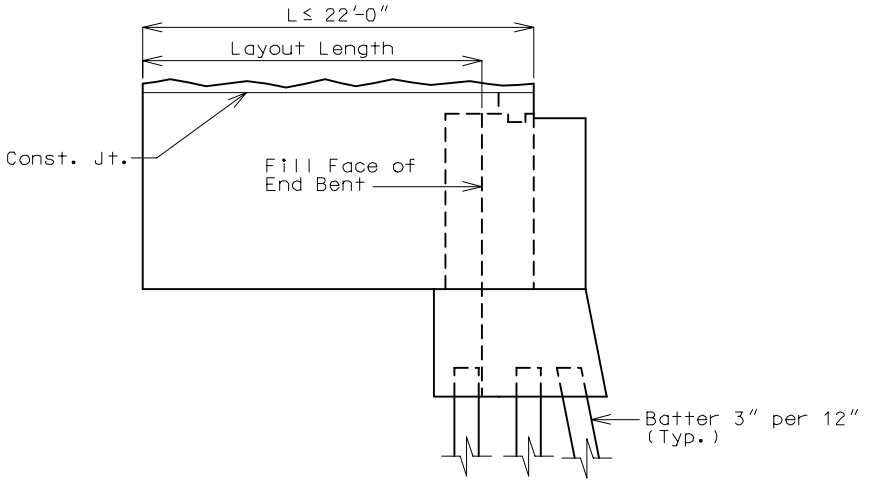
Temperature

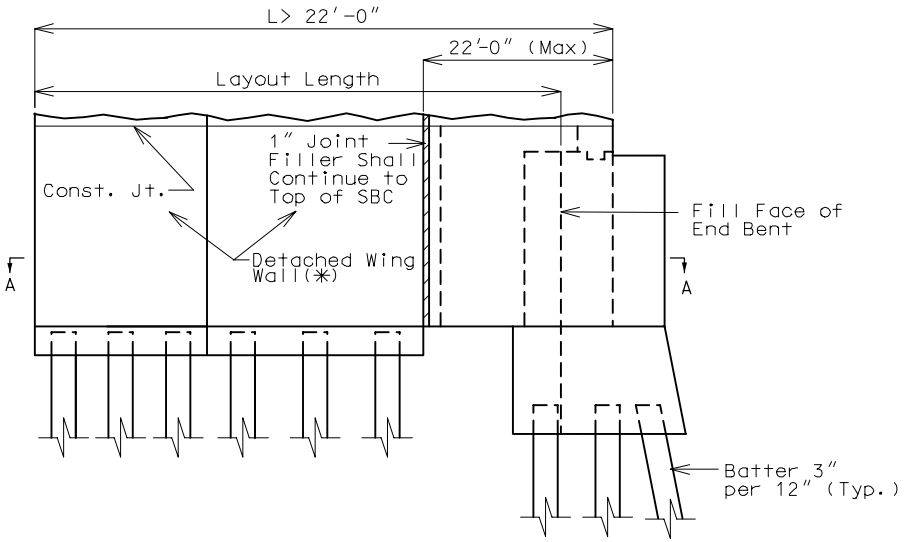
The force due to expansion or contraction applied at bearing pads are not used for stability or pile bearing computations. However, the movement due to temperature should be considered in the bearing pad design and expansion device design.

DISTRIBUTION OF LOADS (CONT.)

Wing with Detached Wing Wall

When Wing Length, L, is greater than 22'-0", use maximum of 22'-0" rectangular wing wall combined with a detached wing wall.



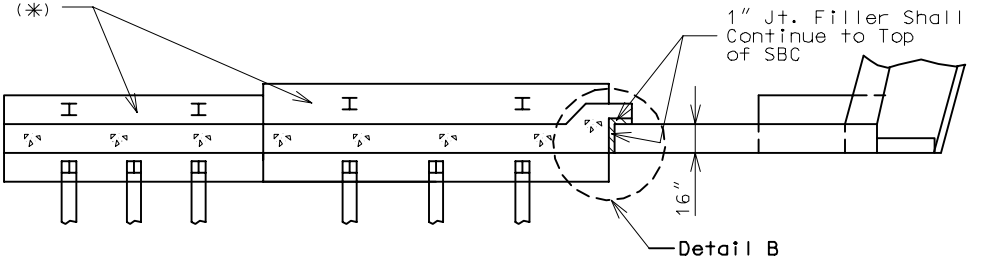


(*) Detached wing wall shown is for illustration purpose only. Design detached wing wall as a retaining wall, see LRFD DG Sec. 3.62.
For details of Section A-A, see page 2.2-3 of this section.

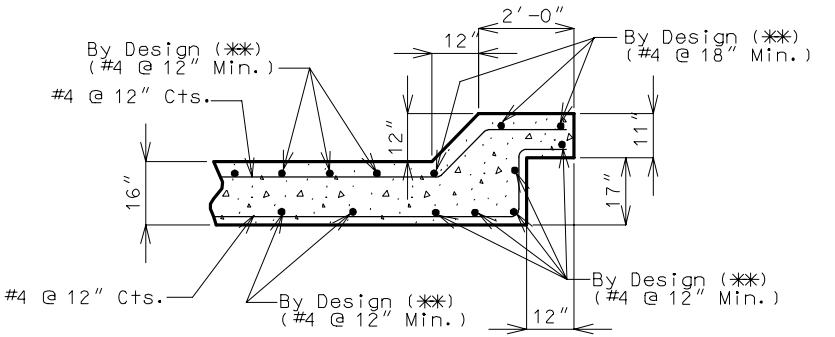
Design

DISTRIBUTION OF LOADS (CONT.)

Wing with Detached Wing Wall (Cont.)



SECTION A-A



DETAIL B

(*) Detached wing wall shown is for illustration purpose only. Design detached wing wall as a retaining wall.

(**) Use retaining wall design.

For location of Section A-A, see page 2.2-2 of this section.

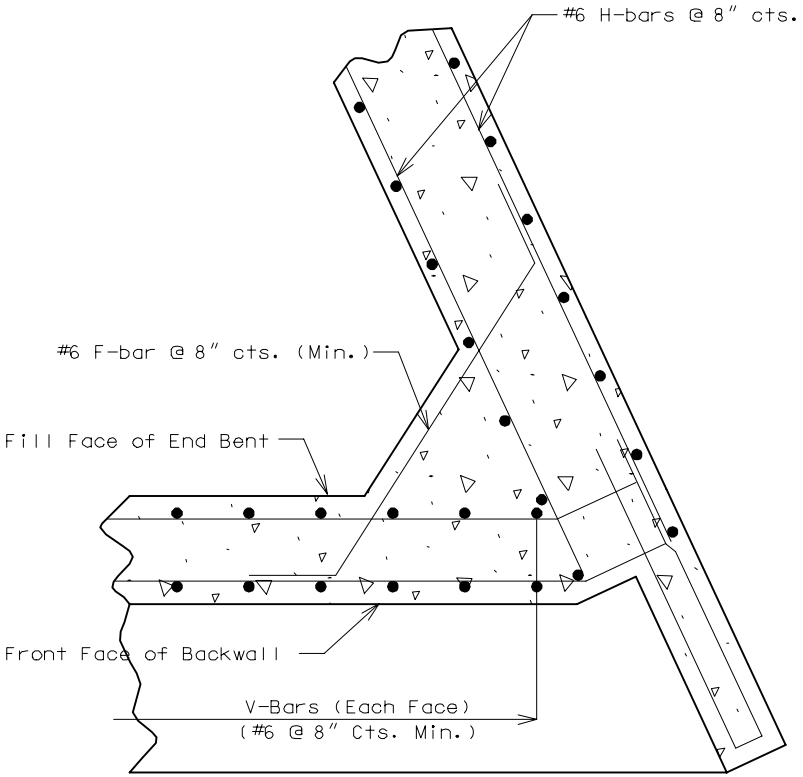
2.3 DESIGN ASSUMPTIONS - LOADINGS

(1) Beam

The beam shall be assumed continuous over supports at centerline of piles. One half of the dead load of the approach slab shall be included in the beam design.

(2) Wing and Backwall

(a) Vertical Loads
The minimum steel placed horizontally in wings shall be #6 bars at 8" centers, each face. These bars should be adequate to support the wing. See figure below.



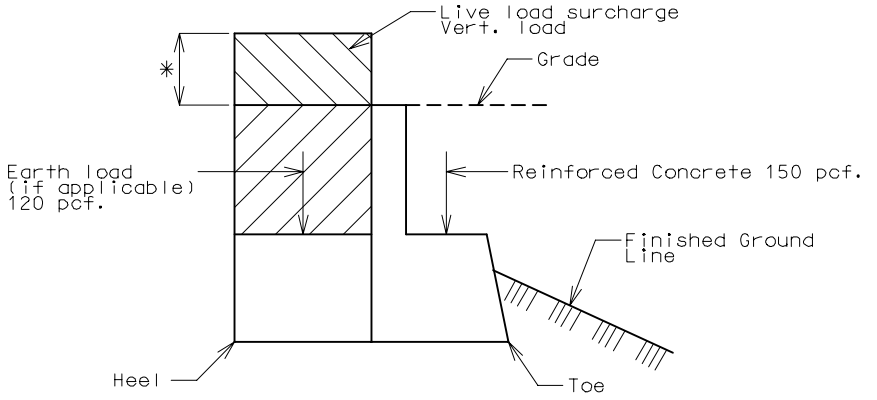
PART SECTION THRU BACKWALL AND WING

Note: The minimum steel (horizontally) in the corner haunch at the junction of the wing and backwall shall be #6 bars at 8" cts.
" ⌐ ".

DESIGN ASSUMPTIONS - LOADINGS (CONT.)

(2) Wing and Backwall (Cont.)

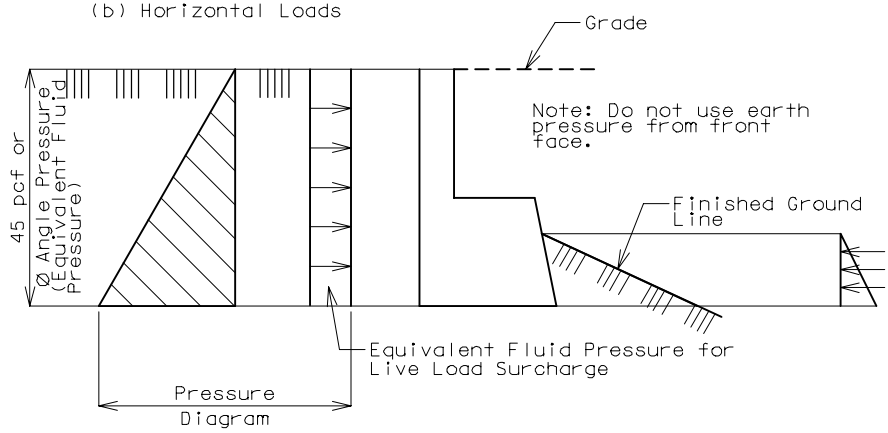
(a) Vertical Loads (Cont.)



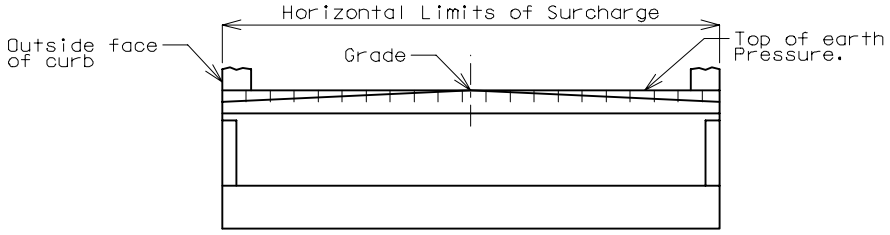
DEAD LOAD & LIVE LOAD

* See LRFD DG Sec. 1.2 pg 1.2-2

(b) Horizontal Loads



EQUIVALENT FLUID PRESSURE AND LIVE LOAD SURCHARGE



LIMITS OF EARTH PRESSURE AND SURCHARGE

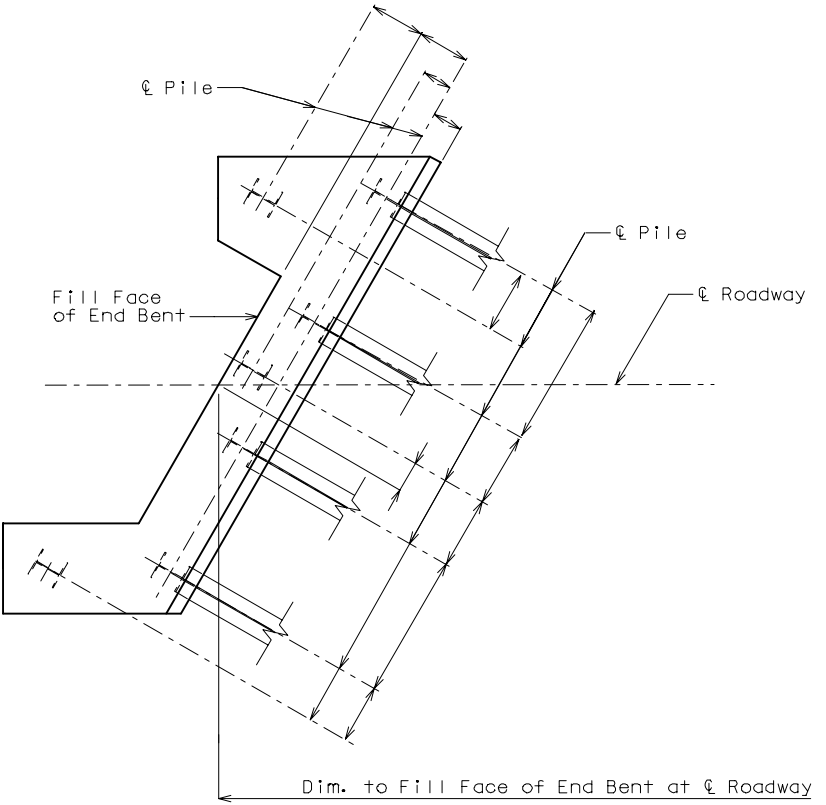
Dimensions

3.1 FRONT SHEET

Notes: The following are details and dimensions for the plan view on the Front Sheets.

Details for unsymmetrical roadways will require dimensions tying Centerline Lane to Centerline Structure.

Note: Pile arrangement shown is for illustrating dimensions and should not be considered as a recommended pile arrangement.

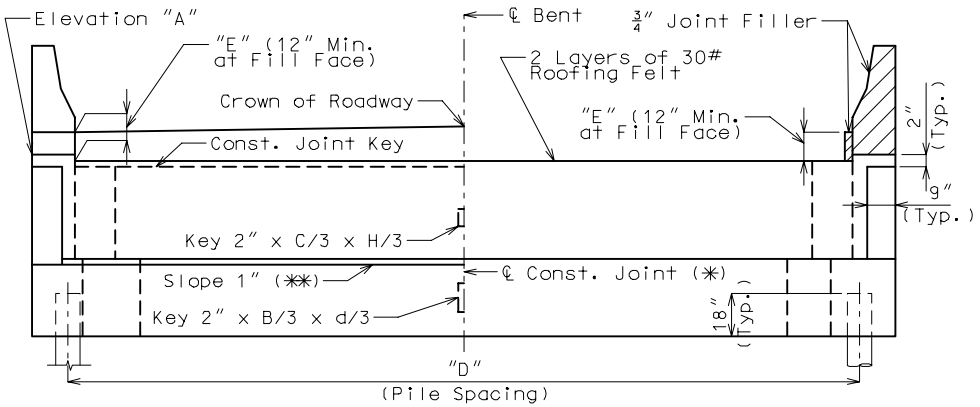


NON-INTEGRAL END BENTS

Steel piles shown, CIP piles similar.
Left advance shown, right advance similar.

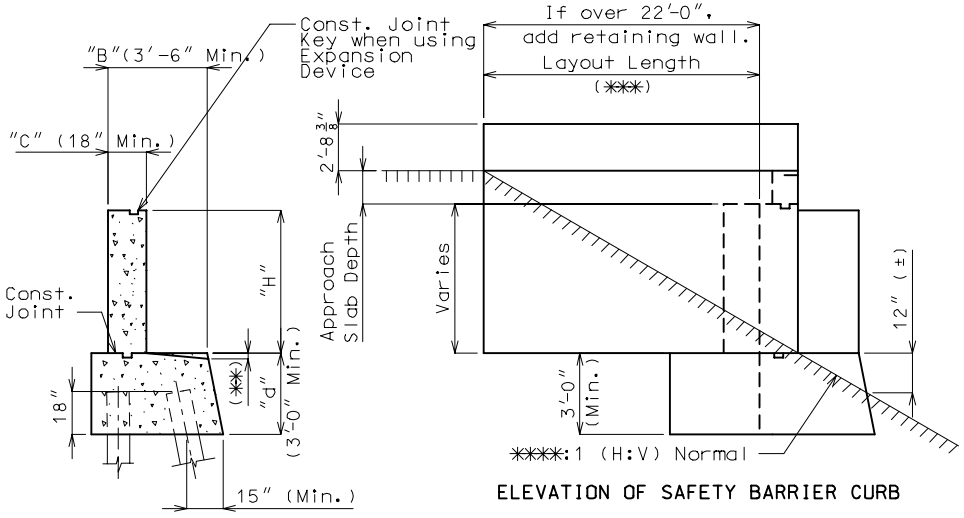
Dimensions

3.2 WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS



EXPANSION DEVICE NO EXPANSION DEVICE

Note: Provide a minimum of 9" CL. from outside edge of pile to face of beam.



PART SECTION AT CENTERLINE

ELEVATION OF SAFETY BARRIER CURB

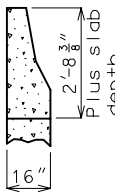
* When the total length of a beam and backwall exceeds 60'-0", use a keyed construction joint at or near CL bent as shown, preferably located at 1/4 point between piles. Maximum key length equals 18". For multiple keys make total key length equal to H/3 or d/3.

** Slope top of beam 1" when using expansion devices.

*** Wing layout length shall be rounded to the next higher foot. See the profile sheet for length of wing to fill face.

**** See Design Layout for maximum slope of spill fill.

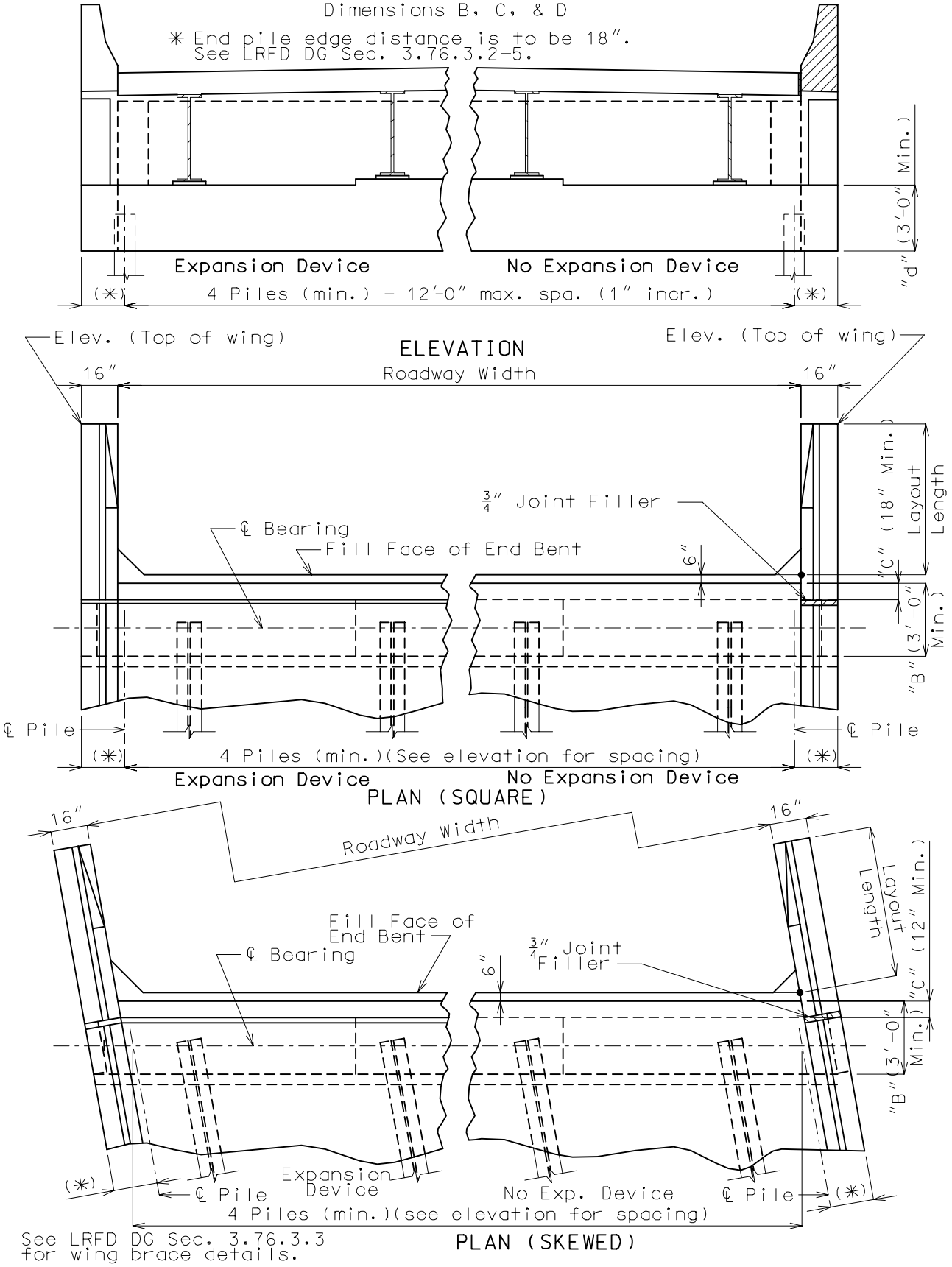
Note: For dimensions not shown, see the following sheets.



PART SECTION THRU 16" BARRIER CURB

Dimensions

WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)

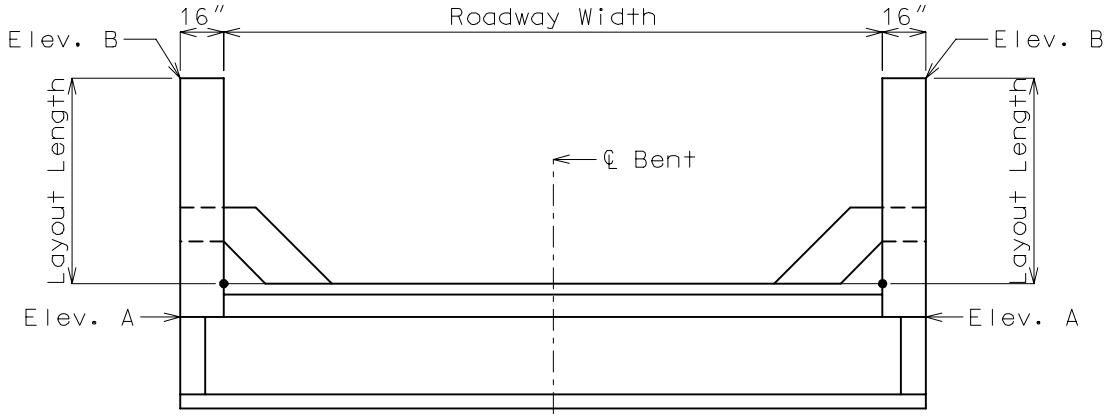


See LRFD DG Sec. 3.76.3.3 for wing brace details.

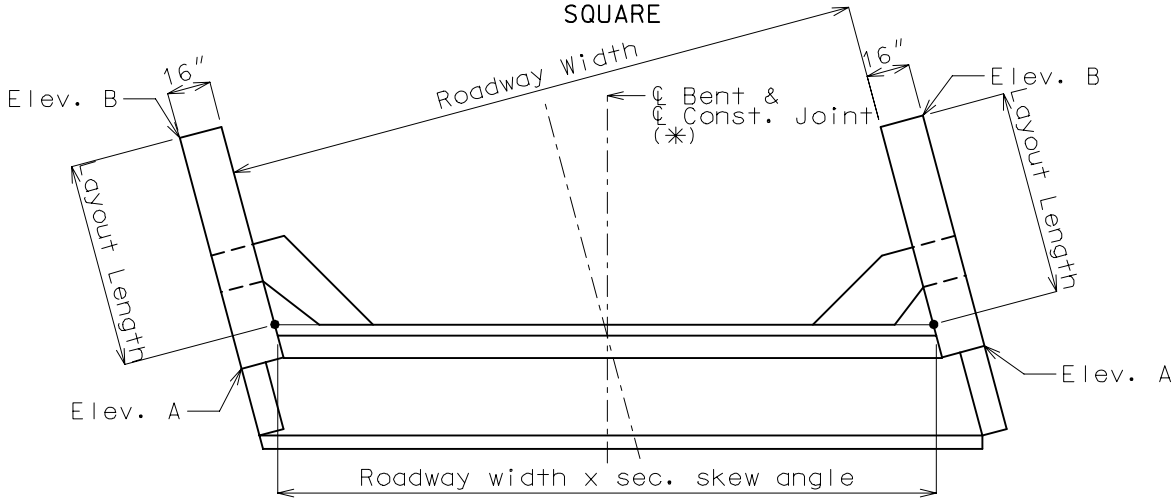
Dimensions

WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)

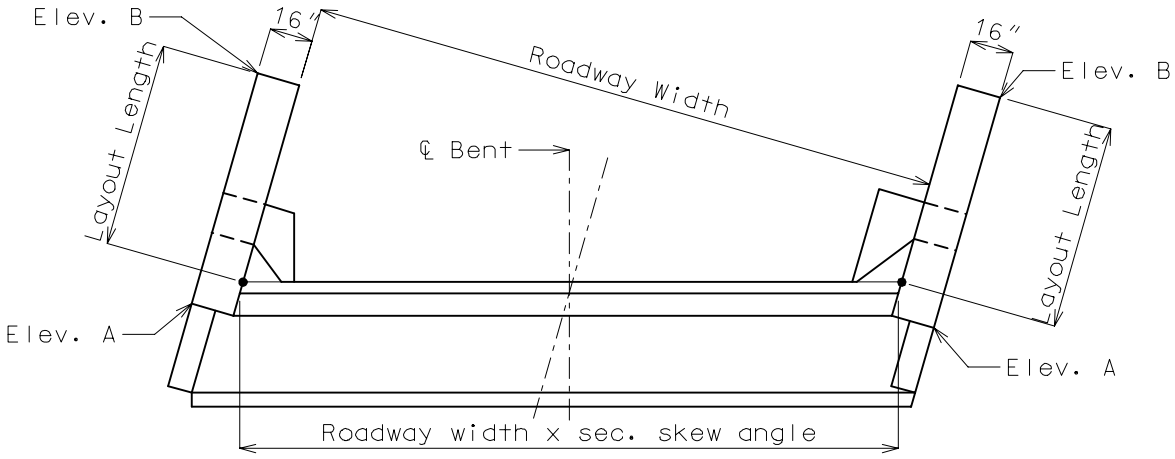
WING LAYOUT, ELEVATION A



SQUARE



SKEWS THRU 15°- LEFT ADVANCE SHOWN

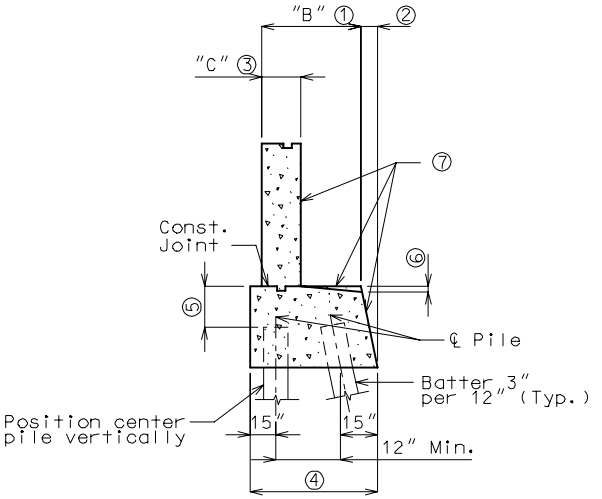


SKEWS OVER 15°- RIGHT ADVANCE SHOWN

See LRFD DG Sec. 3.76.3.3 for Wing Brace details.

✳ When total length of beam and backwall exceeds 60′-0″, show a keyed construction joint at or near the centerline of bent as shown, preferably located at the 1/4 point between piles. Unless required by design or stage construction, this construction joint shall be shown as optional on the plans and may be eliminated at the contractor's discretion.

WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)
DIMENSIONS B & C



TWO ROWS OF PILES

SECTION THRU BENTS

Note: Provide a minimum of 6" cl. from outside edge of pile to face of beam.

① 3'-6" min. (1" Increments).

② When this dimension is less than 6", make the front face vertical.

③ Use 18" min. thickness.

④ 4'-0" min. (1" Increments).

⑤ Check clearance of anchor bolt well to top of pile. Increase beam depth, if needed.

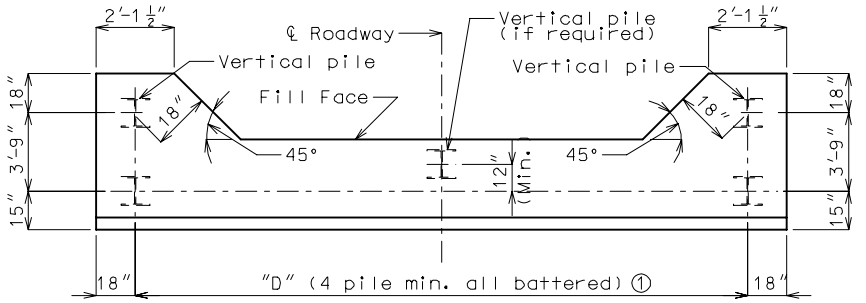
⑥ Slope top of beam 1" when using expansion device only.

⑦ Apply protective coating to the backwall, top of beam cap and front face of beam cap when using expansion devices in accordance with Sec 711, Concrete Bents and Piers (Urethane or Epoxy).

WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)

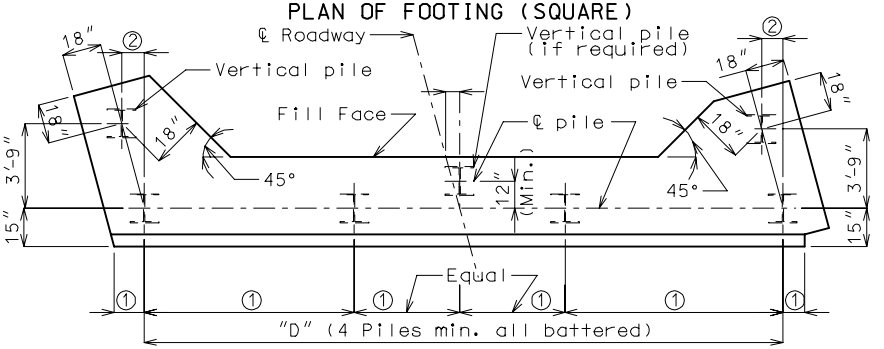
DIMENSIONS D

Note: Pile arrangements shown is for illustrating minimum dimensions only and should not be considered recommended arrangements.

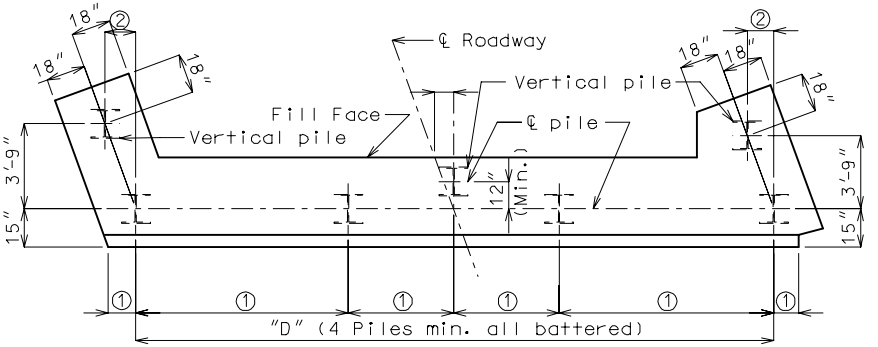


5 Piles-position center pile vertically

PLAN OF FOOTING (SQUARE)



PLAN OF FOOTING (SKEWS THRU 15°- LEFT ADVANCE)



PLAN OF FOOTING (SKEWS OVER 15°- LEFT ADVANCE)

① End pile edge distance is to be 18". Max. pile spacing = 12'-0". Pile spacing increments to be dimensioned as computed (1" increment).

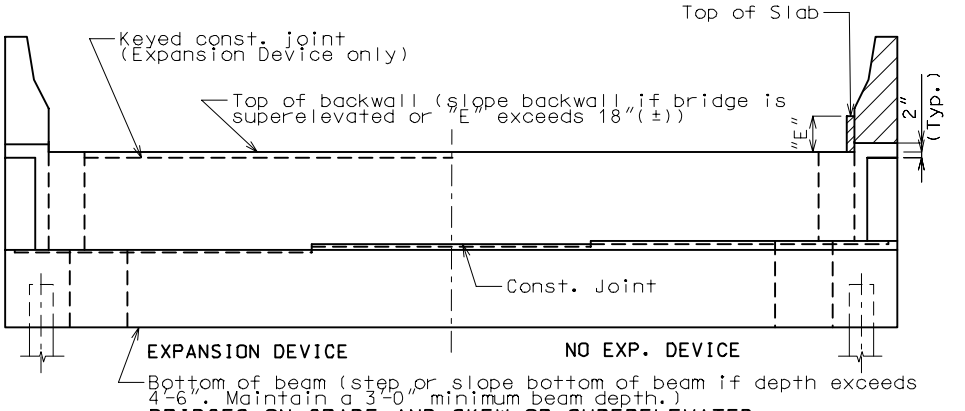
② Show on plans. For exceptions to these dimensions, see the Structural Project Manager.

Steel piles shown, CIP piles similar.

Left advance shown, right advance similar.

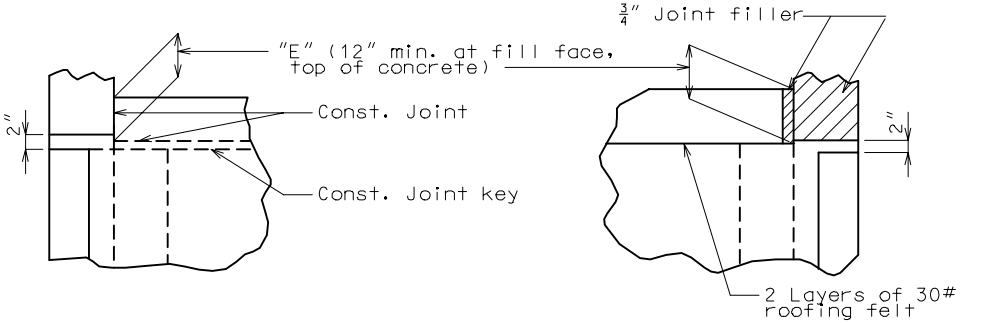
Dimensions

WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)
DIMENSIONS E



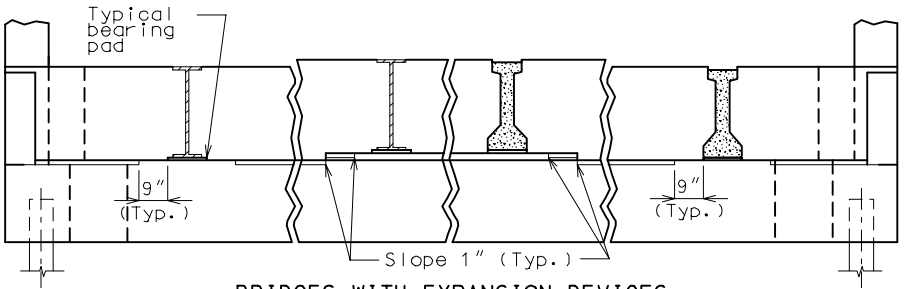
BRIDGES ON GRADE AND SKEW OR SUPERELEVATED

(WITH OR WITHOUT EXPANSION DEVICE)



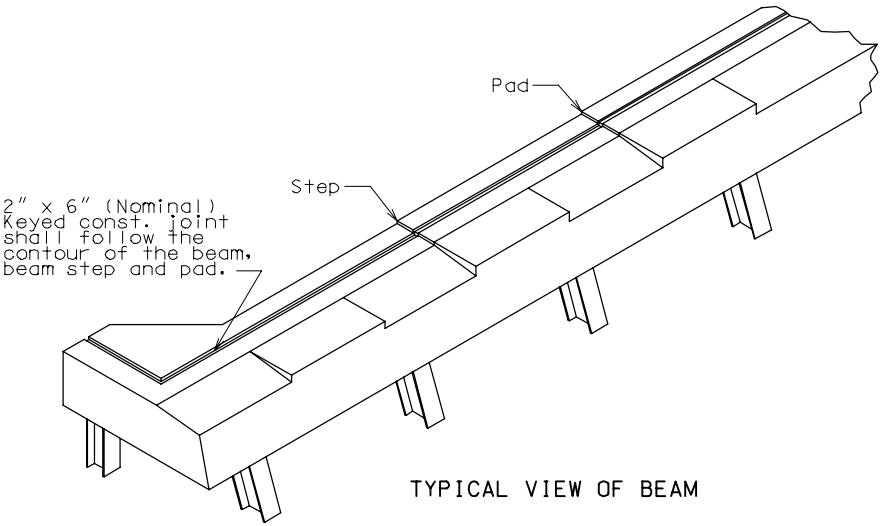
EXPANSION DEVICE NO EXPANSION DEVICE

Note: Provide a minimum of 6" clearance from outside edge of pile to face of beam.

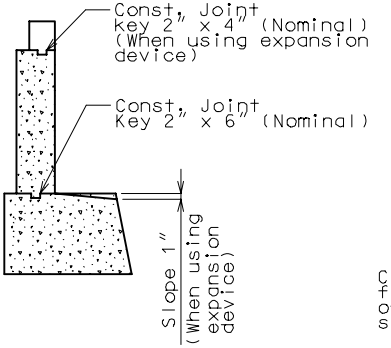


BRIDGES WITH EXPANSION DEVICES

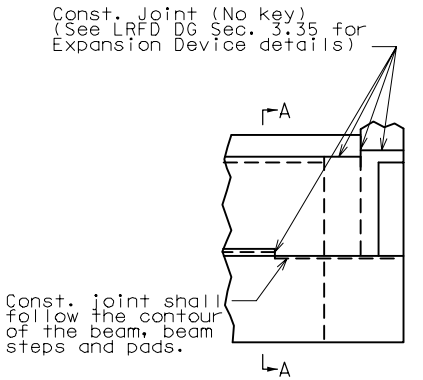
WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)
CONSTRUCTION JOINTS AND KEYS



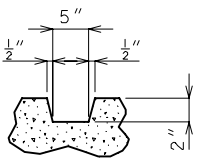
TYPICAL VIEW OF BEAM



PART SECTION A-A



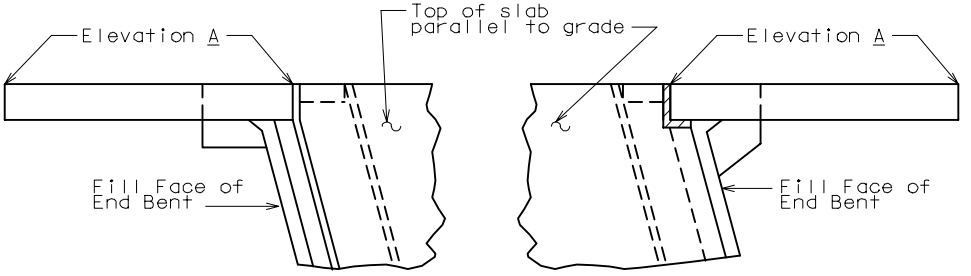
PART ELEVATION



DETAIL OF KEYED CONST. JOINT

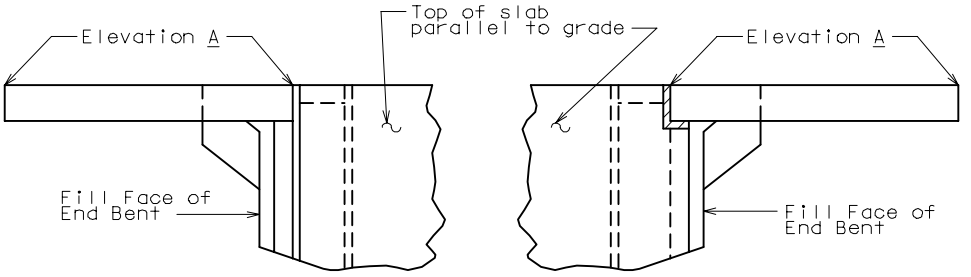
Dimensions

WIDE FLANGE BEAMS, PLATE GIRDERS & PRESTRESS GIRDERS (CONT.)
SAFETY BARRIER CURB AND ELEVATION A



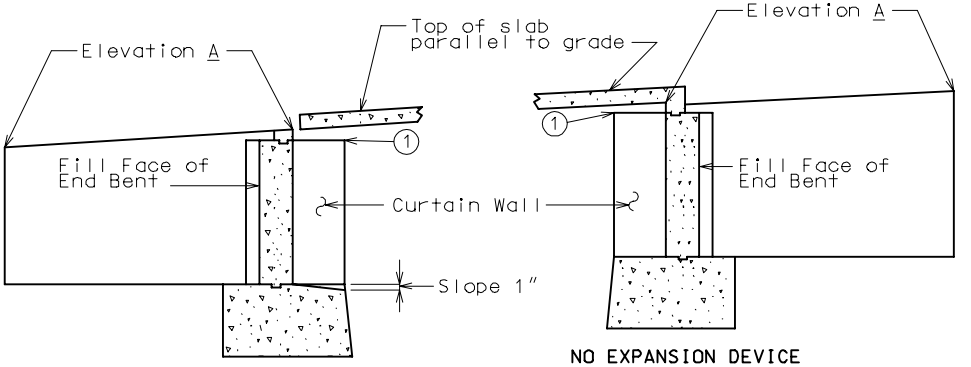
EXPANSION DEVICE NO EXPANSION DEVICE

PART PLAN (SKEWED)



EXPANSION DEVICE NO EXPANSION DEVICE

PART PLAN (SQUARE)



EXPANSION DEVICE NO EXPANSION DEVICE

(1) Top of curtain wall shall not intrude bottom of slab. If necessary slope top of curtain wall.

SECTIONS NEAR LEFT WING

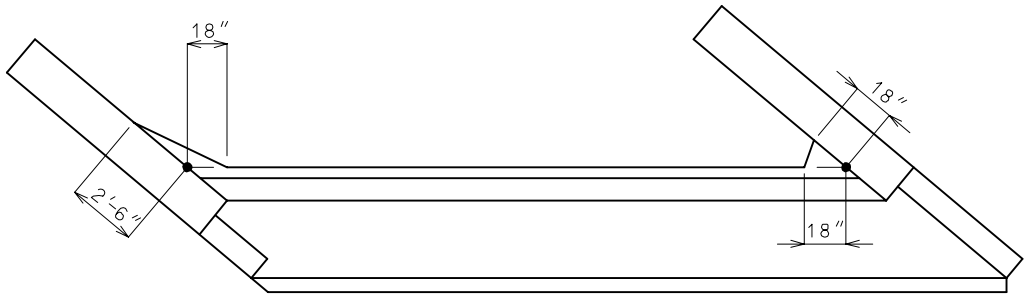
Elevation A - Wing elevation is determined at this point for bridges on grade.

3.3 WING BRACE DETAILS

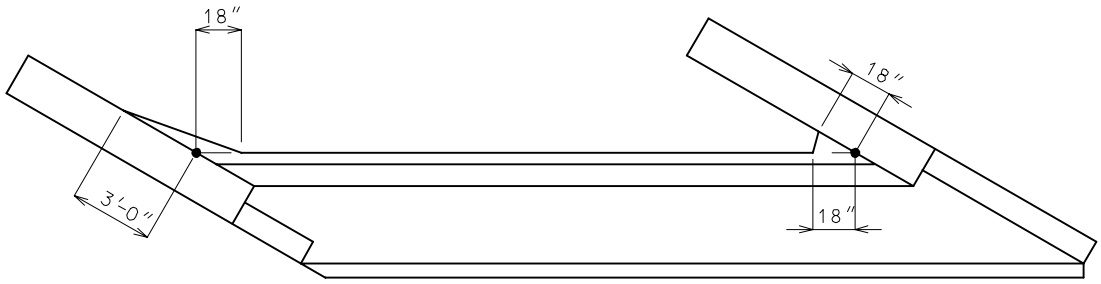
Dimensions

The wing brace dimensions will only vary on the wing with obtuse angle. Wing brace dimensions shown are minimum dimensions. The wing with the acute angle will always be 18″ minimum.

SKEWS THRU 0° TO 45°



SKEWS THRU 45°00′01″ TO 55°



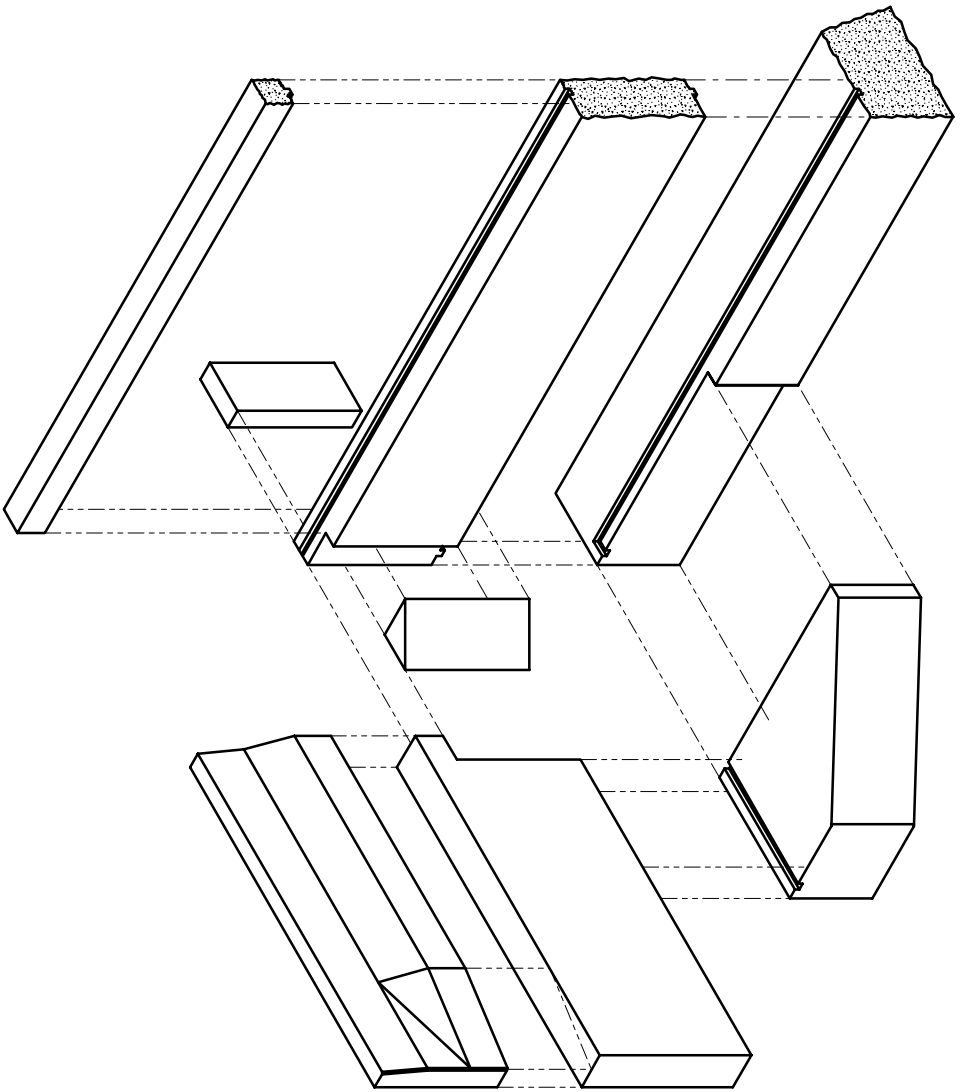
SKEWS THRU 55°00′01″ AND OVER

Note:

Left advance shown, right advance similar.

3.4 EXPLODED VIEW OF THE END BENT Details

SQUARE - STRAIGHT - TURNED BACK WINGS



Note: Exploded view above is for information only.